Chapter 1

What is Energy: Capacity to do work.

Energy forms:

→ Chemical Energy

→ Thermal Energy

→ Nuclear Energy

→ Electrical Energy

Why Electrical Energy has gained popularity as primary energy source for many applications over the other forms?

→ It can be easily controlled

→ Transmitted over very long distances

→ Can be converted into any other form of energy conveniently

Electrical Power System:

→ Electricity in large amount cannot be stored.

→ It has to be generated when we need it.

→ This makes it necessary to have a system to Generate, Transmit and Distribute electrical energy. This system is called Electrical Power System.

Electrical Power System:

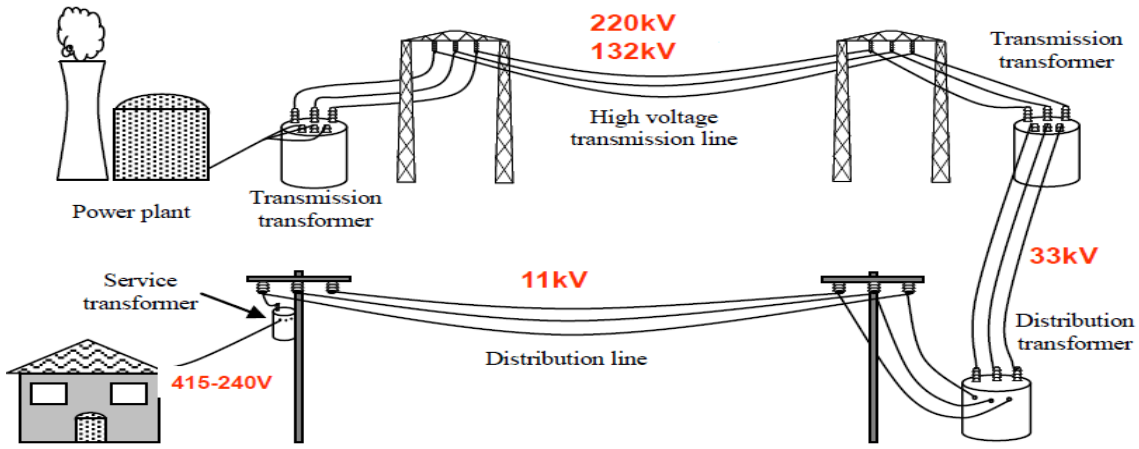
Arrangement of components

→ Generation

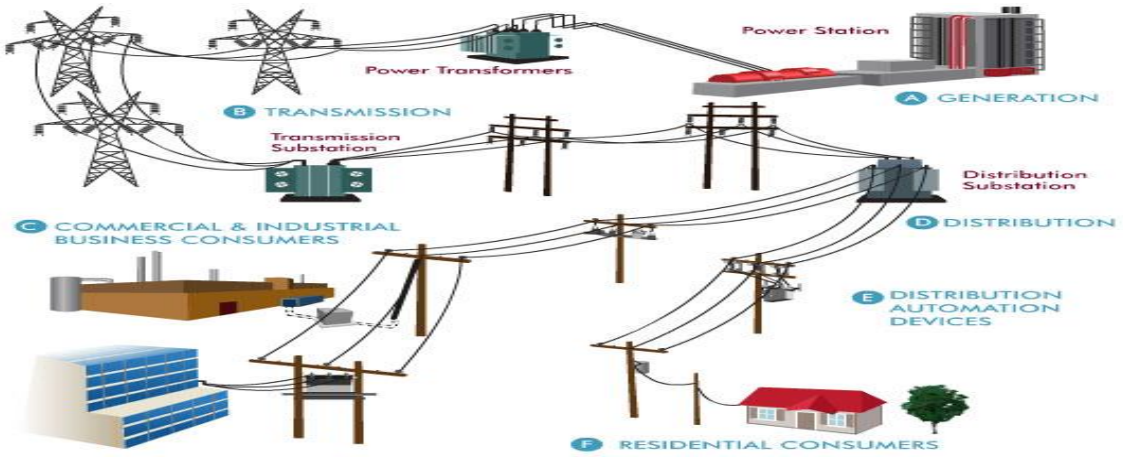
→ Transmission

→ Distribution

Typical Electrical Power System in Oman:



→ Representing a real life system consisting many generating stations, voltage levels and loads in conventional way is difficult and also may not be necessary.



→ It is essential however to know the interconnection of the various components of the system to understand and analyze flow of power under normal and abnormal conditions. A technique to simplify the representation of an otherwise complex system is Single Line Diagram (SLD).

Single Line Diagram (SLD):

1. These are three phase networks and have devices installed in all the three phases.
2. Conventional representation of three phase circuits with all the three phases is very complicated and impractical.
3. Three phase systems are designed as balanced systems.
4. Single Line Diagram (SLD) is a convenient way of representing three phase balanced system where a single line represents all the three phases.
5. SLDs represent the relative interconnection of components of the power system such as,

→ Generators

→ Transformers

→ Circuit breakers

→ Transmission lines

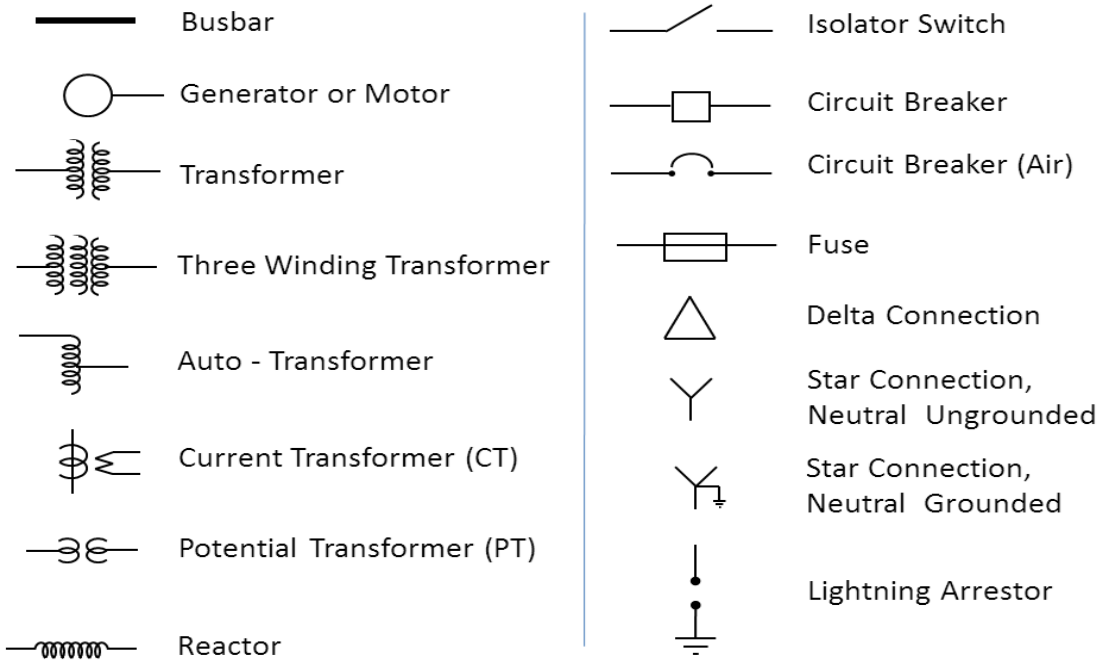
→ Distribution lines

→ Loads

→ Bus bars

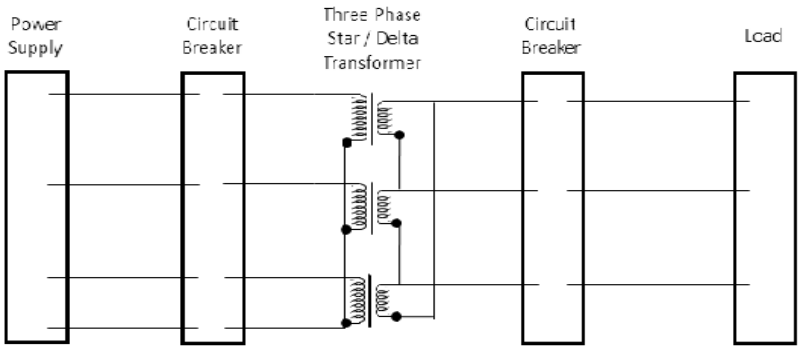
6. Single Line Diagrams may have more or less number of components shown in it depending on the purpose of the diagram.

Symbols used in SLDs

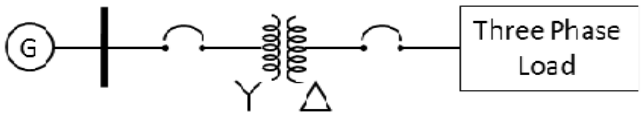


Single Line Diagram: Example

Circuit Diagram:



Single Line Diagram:



Bulk Power Consumers

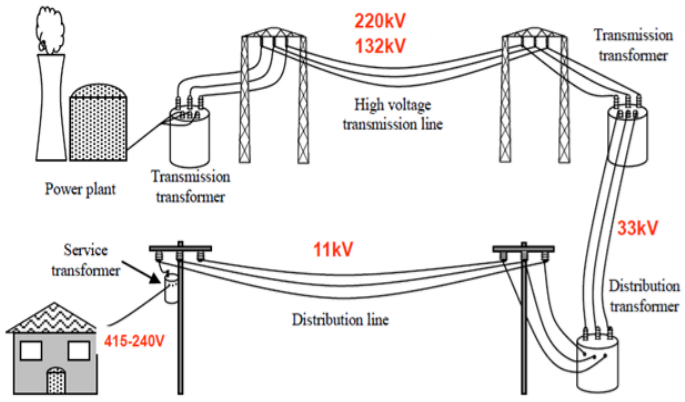
220 kV Connections

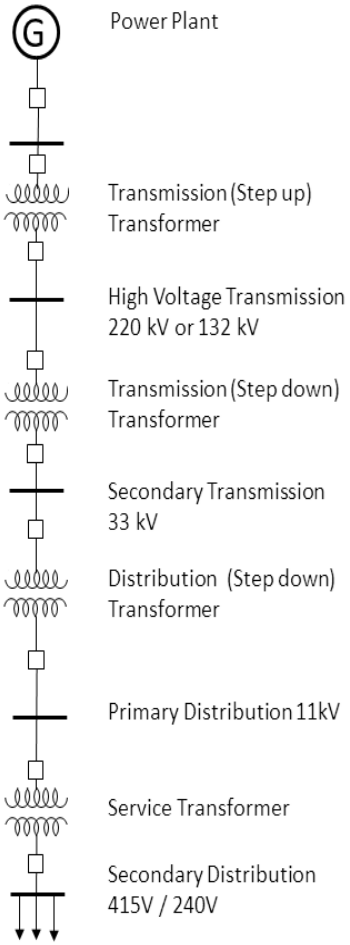
i. Sohar Aluminium
ii. Jindal Shadeed Steel

132 kV Connections

i. ORPIC
ii. Sohar Industrial Estate
iii. Sharq Sohar Steel
iv. PDO
v. Rusail Industrial Estate
vi. OMIFCO

Single Line Diagram





Electricity is generated at **power plant** by three phase alternators operating in parallel, generally at 11 kV.

For economy in the transmission of electric power, the voltage of generated electricity (11kV) is **stepped up** to 132 kV or higher.

High transmission voltages helps saving conductor material and achieve high transmission efficiency. Electricity is transmitted at this high voltage by 3 phase, 3 wire overhead system to the outskirts of the city. **This forms primary transmission.**

The primary transmission line terminates at **Receiving Stations (RS)** which usually lies at the outskirts of the city. At RS the voltage is reduced to 33kV by **step down** transformers.

From receiving stations the electricity is transmitted at 33kV by usually 3 phase, 3 wire overhead transmission lines to various Sub Stations (SS) located at the strategic points in the city. This forms **Secondary Transmission**.

Reference: Principals of Power System, V. K. Mehta

The Secondary Transmission Line terminates at **Sub Station (SS)** where the voltage is reduced further from 33kV to 11kV.

The 11kV overhead (OH) lines or underground (UG) cables run along main roads of the city. This forms **primary distribution**. Large consumers of electricity such as Shinas College of Technology are generally supplied power at 11kV which is handled through their own substations.

Electricity from primary distribution is delivered to Distribution Substations (DS). The voltage is stepped down by the **service transformer** to 415 V.

The **secondary distribution** having 3 phase, 4 wire system (3 lines and 1 neutral wire) provides line voltage of 415 V for three phase loads and 240 V for single phase loads.

Reference: Principals of Power System, V. K. Mehta

DC Distribution:

1-Two wire dc system ➔

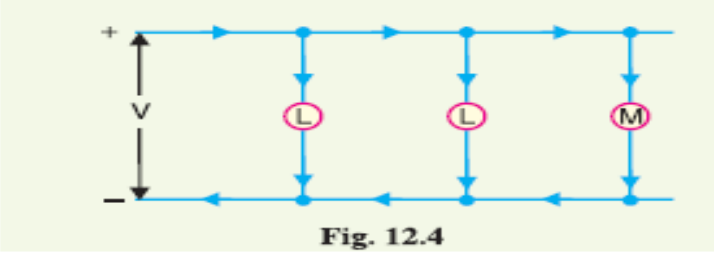


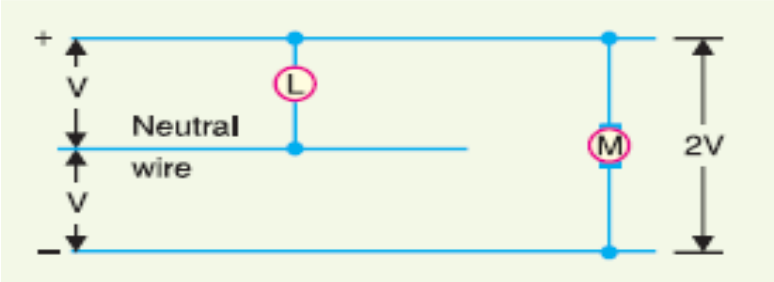
Fig. 12.4

→ This system consists of two wires.one is the outgoing or positive wire and other is return or negative wire.

→ The loads such as lamps and motors etc. are connected in parallel between the two wires.

→ This system never used for transmission due to low efficiency, can be used for distribution of DC power

2-Three wire DC System ➔



→ It consists of two outers and a middle or neutral wire which is earthed at substation.

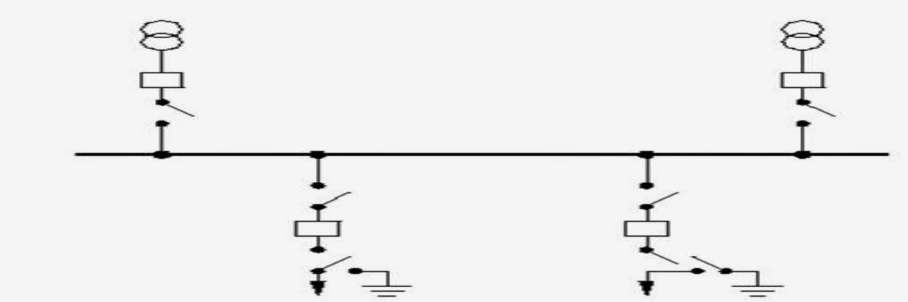
→ The voltage between outers is double than the voltage between outer and neutral.

→ The principal advantage of this system is that it makes available two voltages.

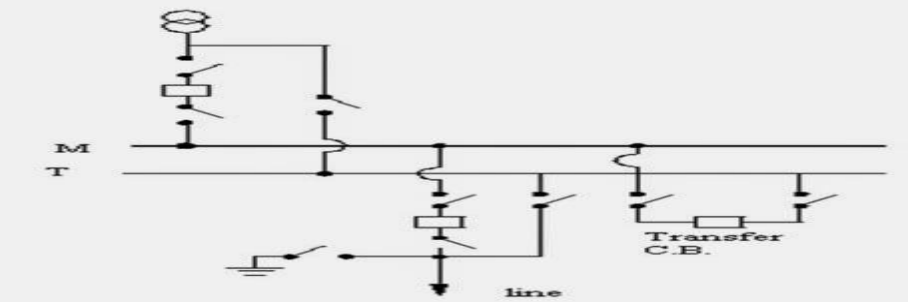
→ Across the outers high voltage loads like motors and across outer and neutral less voltage loads like lamps can be connected

TYPES OF DIFFERENT BUS BAR SYSTEM:

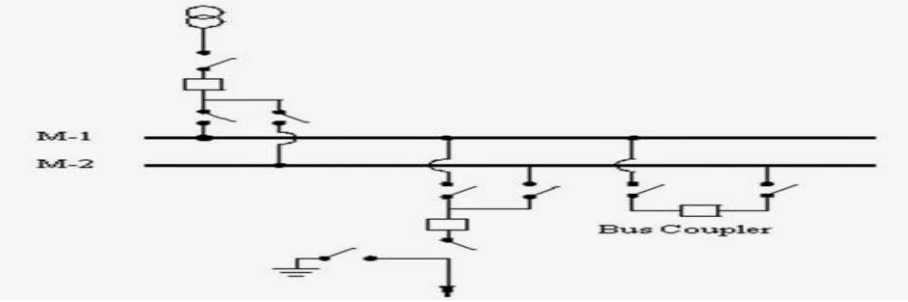
1. **Single bus bar system**



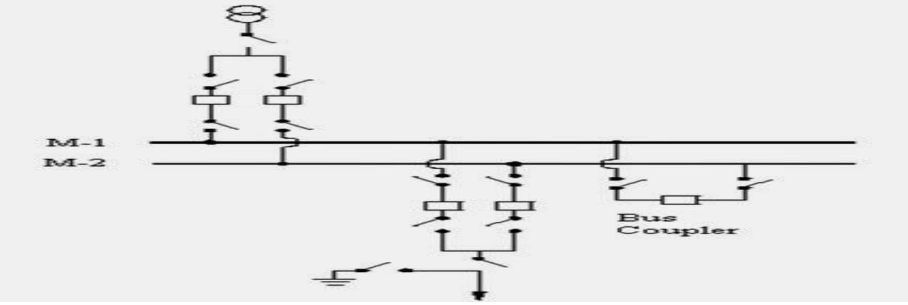
2. **2 Main & Transfer Bus bar System**



3. **3 Double Bus bar Single Breaker system**



4. **4 Double Bus bar with Double Breaker System**



5. **5 Double Main Bus & Transfer Bus bar System**